

Claims:

1. Microorganism, characterized by the presence of a DNA sequence encoding a functional chaperone of a psychrophilic bacterium.
2. Microorganism according to claim 1, characterized in the DNA sequence encoding a functional chaperonin of a psychrophilic bacterium.
3. Microorganism according to claim 1, characterized in the DNA sequence encoding the chaperonin Cpn60 and/or Cpn 10 (SEQ ID No 1 and/or 2) of *Oleispira antarctica*.
4. Microorganism according to claim 1, characterized in the DNA sequence encoding a functional homolog of the chaperonin Cpn60 and/or Cpn10 of *Oleispira antarctica* (Seq ID Nr. 1 and/or 2) from a psychrophilic bacterium.
5. Microorganism according to claim 4, characterized in that the psychrophilic bacterium is selected from the group consisting of *Moraxella*, and *Alteromonas haloplanktis*.
6. Microorganism according to claim 1, characterized in the DNA sequence encoding a functional mutant of the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) of *Oleispira antarctica*.
7. Microorganism according to claim 1, characterized in the DNA sequence encoding the stabilized single ring mutant chaperonin Glu461Ala/Ser463Ala/Val464Ala of Cpn60 (Seq ID No 11) or the mutant chaperonin Lys468Thr/Ser471Gly and/or Cpn 10.
8. Microorganism according to one of the preceding claims, which is selected among animal cell lines, plant cell lines, gram-positive or gram-negative bacteria, fungi and yeasts.
9. Microorganism according to one of the preceding claims, characterized in that the heterologous protein has enzymatic activity or hormonal activity in its native conformation.
10. Microorganism according to one of the preceding claims, characterized in that the DNA sequence encoding a functional chaperone is located chromosomally, extra-chromosomally, or mitochondrially, or in chloroplasts of plants.
11. Process for producing a protein by heterologous expression in a host microorganism containing a gene sequence encoding the heterologous protein, characterized in that a microorganism according to one of the preceding claims is used.
12. Process according to claim 11, characterized in that the host organism is cultivated at a temperature below 25 °C, preferably 4 to 15 °C.

13. Process according to claim 11 or 12, characterized in that the heterologous protein is selected from the group consisting of mammalian proteins, psychrophilic mammalian or bacterial proteins, mesophilic bacterial, fungal or yeast proteins, and mutant or fusion variants thereof.
14. Process for changing the conformation of denatured proteins into their native and/or active conformation, characterized by the step of contacting the denatured protein with a functional chaperone of a psychrophilic bacterium.
15. Process according to claim 14, characterized in that the chaperone is the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) of *Oleispira antarctica* in presence of at least one nucleotide, preferably adenosine triphosphate.
16. Process according to claim 11, characterized in that the chaperone is a functional homolog of the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) from a psychrophilic bacterium or a functional mutant of the chaperonin Cpn60 and/or Cpn 10 (Seq ID No 1 and/or 2) of *Oleispira antarctica*.
17. Process according to one of claims 11 to 16, characterized in that the contacting is performed extracellularly or *in vitro*.
18. Process according to claim 17, characterized in that the contacting uses at least one immobilized chaperone.
19. Plant, characterized in that it can grow at lower ambient temperatures due to the presence of a DNA sequence encoding a cold-active functional chaperone of a psychrophilic bacterium or plant.
20. Plant according to claim 19, characterized in the DNA sequence encoding a functional chaperonin selected from the group consisting of Cpn60 and/or Cpn 10 (SEQ ID No 1 and/or 2) of *Oleispira antarctica*, a functional homolog thereof, and the stabilized single ring mutant chaperonin Glu461Ala/Ser463Ala/Val464Ala of Cpn60 (Seq ID No 11).

**Figure 1:****Amino acid sequences of Cpn60 and Cpn10:****SEQ ID No 1: Cpn10 (encoded by nucleotides pos. 458-751 of Figure 2):**

MKIRPLHDRVVRREEETATAGGILPGAAAEKPNQGVVISVGTGRILDNGSVQALA  
VNEGDVVVFGKYSGQNTIDIDGEELLILNESDIYGVLEA

**SEQ ID No 2: Cpn60 (encoded by nucleotides pos. 800-2446 of Figure 2):**

MAAKDVLFGDSARAKMLVGVNILADAVRVTLGPKGRNVVIEKSFGAPIITKDGVSV  
AREIELKDKFENMGAQMVKEVASQANDQAGDGTATVLAQAIIEGLKSVAAGMN  
PMDLKRGRIDKATAAVVAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV  
GKEGVITVEEGKGLEDEL DVVEGMQFDRGYLSPYFINNQEKM TVEMENPLILLVDKK  
IDNLQELLPILENVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVA AVKAPGFGD  
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS  
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVA VIKVGAGSEMEMKEKKDRVD  
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI  
AGNAGAEGSVVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPKAVTRSSLQAAASI  
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMGMPGMM

**Figure 2:****SEQ ID No 3: DNA coding for Cpn60 and Cpn10:**

Cpn10, pos. 458-751

Cpn60, pos. 800-2446

atcaaaaaatgcagcaaggacagattcctgcccaagaattagcagaagggttctttagcactggccggcgcttattattaacgccgg  
gtttgtcactgatgcgctgggtttacattactcgtccccgcgacgcgttaaagcgttggtccataaggtgattgcatttattaccctc  
gcatgatgactgcaagcagcttcaagcgacggtagttttcaggaaggctcgttaaagatgtacattcgcacactgactcgcaagca  
gtcatgaaaaaatcacaattgaaggcgaatataccaagacgataagtaggtatttttcggctagccggttgaaatcctagtaaaagccc

cgataaattaacctatctatctttcacagaggcaatttagcctttgtttaccttattgatcctaatacttgggatccaacagttggagagtctagc  
aatgaaaatccgtccattacatgatcgtattgttgcgccgtaagaagaagagaccgcaactgcgggtgtattattttacc  
gggcgctgcggcagaaaaacaaatcaaggtgttattctctgtgggtactggccgtattcttgataatggttcagtgaagcgctggc  
ggtaacgaaggcgatgttgcgtttttggttaatactcagggtcaaaatactatcgatatcgatggtgaagaattattgatttgaatga  
aagtgatctacggcggtttagaagcttaattactcactcttttttaacctacaaaatttaaggaaagatcatggctgctaagacg  
tattatttggtagatgcgcacgcgcaaaaatgttggtaggtgtaaacatttttagccgacgcagtaagagtacctaaggaccta  
aggctgtaacgttgttatagaaaaatcatttgggtgcaccgatcatcaccaaagatggtgtttctgttgcgcgtgaaatcgaattgaaagaca  
aattgaaaacatgggcgcacagatggtaaggaagttgcttctcaagccaacgaccaagccggtgacggcacaacgacagcgact  
gtactagcacaggcgattatcagcgaaggcttgaatctgttgcggctggcatgaatccaatggatcttaacgtggtattgataaagcta  
cggctgctgttgttgcgccattaaagaacaagctcagccttgccttgatacaaaaagcaatcgctcaggtagggacaatctctgccaatg  
ccgatgaaacggttggctgttaattgctgaagcgatggaaaaagtcggttaagaaggtgtgattaccgttgaagaaggcaaaaggcctt  
gaagacgagcttgatgtttagaaggcatgcagttcgatcgcggttactgtctccgtacttcatcaacaaccaagaaaaatgaccgta  
gaaatgaaaatccattaattctattggttataagaaaattgataacctcaagagctgttgccaattcttgaanaacgtcgctaaatcaggt  
cgtccattattgatcgttgcgaagatgttgaaggccaagcactagcaacattggtagttaacaacttgcgcggcacattcaaggttgc  
agcgggttaaagccccgttggcgatcgtcgtaaagcgatgttgaagatcttgcacatctgacgggtgtcagggtatttctgaagag  
ctagggtatgtttagaaactgcggatccttcttcttgggtacggcaagcaaggtgttatcgataaagaaaacaccgtgattgttga  
tggcgcagggtactgaagcaagcgttaatactcgttggaccagatccgtgctgaaatcgaaagctcgacttctgattacgacatcgaaaa  
gttacaagaacgcgttgctaagcttgcggcgcggttgcctgattaaggttgggtgcgggttctgaaatggaatgaaagagaagaaa  
gaccgtgttgacgatgcacttcatgcaactcgcgcagcggtgaagaaggtgttgcgggtgtgtgttgccttgattcgcgcactct  
cttcagtaaccgttgttggtgataacgaagatcaaaacgtcggtattgcatggcacttctgtcgatggaagctcctatccgtcaaatcgc  
gggtaacgcagggtgctgaagggtcagtggttgttataaagtgaatctggcacaggtagcttgggtttaaaccagcacagggtgagt  
atggcgatatgattgcgatgggtattttagaccctgcaaaagtcacgcgttcatctctacaagccgcggtctatcgaggttgcgat  
cacaaccgaagccatggttgcggatgcgcctgttgaagaaggcgtggtggtatgcctgatatggcgggcatgggtggaatgggcg  
gtatgcctggcatgatgaatcatttgcattcattgtcctgatctgcttaccgtgtaaaaagatcagggtcaaggctgtctctataaaaag  
ccgtatcttgcgatgagtggttcttctgctgaaaacgacattcttgagtgccggttttttgatttggtcataaaattcagaatattgtgaatt  
ttatgtaactagctggcctataatgttgagttcctctgggtggcatgatctcatggtacttcaagcctgattcactgcg  
gctttaacagtaaaataataacgcaacgtagaacataataagcgatggcattaatgaagacggctgcatttaattcagatc

**Figure 3:**

SEQ ID No 4: Amino acid sequence of esterase cloned from *Oleispira antarctica* (EstRB8):

EstRB8 (encoded by nucleotides 1145 to 2143 Frame 2 of Figur 4) 333 aa

MKNTLKSSSRFSLKQLGTGALISSLFFGGCTTTQQDNLYTGVM SLARDSAGLEVKTA  
 SAGDVNLTYMERQGSDDNAESVILLHGFSADKDNWILFTKEFDEKYHVIAVDLAG  
 HGDSEQLLTDDYGLIKQAERLDIFLSGLGVNSFHAGNSMGGAIYSLSHPEKVKSL  
 TLIDAAAGVDGDTSEYKYVLAEGKNPLIATDEASFEYRMGFTMTQPPFLPWPLRPSLL  
 RKTLARAEINNKFSDMLKTKERLGMTNFQQKIEVKMAQHPLPTLMWGKEDRVLD  
 VSAAAAFKKIIPQATVHIFPEVGHLP MVEIPSESAKVYEEFLSSIK

**Figure 4:**

SEQ ID No 5: DNA fragment from plasmid pBK1Est coding for esterase of *Oleispira antarctica* (EstRB8):

Nucleotide positions 1-100 correspond to reverse complement of positions 1196-1121 and 3799-3939 correspond to reverse complement of 1043-952 of pBK-CMV vector (Stratagene).

Positions 101-105 are *Bam*HI – *Sau*3A1 fusion and positions 3795-3798 are *Sau*3A1-*Bam*HI-fusion.

acaggaaacagctatgaccttgattacgccaagctcgaaattaaccctcactaaagggaacaaaagctggagctcgcgcgctgcag  
 gtcgacactagtggatcaacggcggtcatgtgactgggtgagttcagcgtcataatgccgatgcgatactggccgtcatgactgagtact  
 tcttctgctagcaccgatttttctaatagcgcagcttcttttattctgaacgggcaactgatgtagtttttactaaccggcttttaggcattgg  
 taaactcttcgatattcaaaattattactgttcattacaatcatagtagcaggctagaggcccaaaattgcagctgatattcacctttattattc  
 taagcattattacactcatcgcggtgttattaattgtgctaaataaaaatacccgtagcggaataattcagcaaatagccaaagaaaacga  
 ttggcaataccaagaattcatcgatttgatgatgacattaagcaggcaaaccttggcctattaaactacagtcaaatgcaatttttagacat  
 ctcatcgaagcaactgacgaacactatggcttagcggttaagaccttgactgtcgagcggttagaaccttcaggtattcacaatagcagctt  
 tattttattaccctgcactaaagactgaattcaataacctacacatttgcttaagtcgacatattcaagataaagatgccttcactgacatca  
 gtcaccaacaatcaatcaaacaccaataccaatcgcaaaaactcataaaactagccgatcaccaaatcccaaaagcggttcaaaaatgaa  
 acgagcacgtcacacaaaatcaatttatacgctaacgaaccagggtcaaaccttatcggtttttgagcacggttgttccactaatgaaagaga  
 aaagtcgttaattcactggcttttggcgatccgcaccttcacatagaaattagtaattggcatgctactggcctttaaagaatcagttaatt  
 gaagaaacctcgcttatctcagccattaccgctgtagccgaatttgcgcttatctcagccatgattaaactgacgccaattatataagac  
 atactaattaataactcccttaattgagaagaataatgaaaaacacactcaaatctcatcacgttttagtctgaaacaactcggcaccggc  
 gctctgattatctccagtttgttcttcgggtgttcaccacaacacaagaataattatacacaggggttatgtctcttgcgagagacagc  
 gctggcctagaagttaaaacagcctctgccgggtgacgtcaatcttacttatatggaacgccaaggcagtgacaaagataatgccgaaag

cggtattttattacacggtttctctgctgataaagataactggattcttttaccaaagaattcgaatgaaaaatcatgttatcgctgtcgattta  
gcgggacatggcgattcagaacaattattaacgactgattacgggtctcataaaacaagccgagcggttagatatcttcttatctggcttagg  
ggttaactcatttcacatcgccggttaattcaatggggggggctatcagcgcaatctacagtttgagtcacccagagaaaagttaaaagtctt  
acattgatcgaatgcagcagggtgctgatggcgatactgaaagcgaatactacaaagtttggcagaaggtaagaatcctttaattgcaact  
gatgaagcaagttttgaataccgcatgggttcacatgactcagcctcttctctaccttggccactaagaccttcttattacgtaaaacg  
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aaaaaataattccacaagcaactgttcatatttttctgaagtaggccacctacctatggtagaattcctagtgaagcgctaaagttaa  
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ccaaattattcaacgaccaagctctgcggttaaaatcgagtggttcttctgtttcatcaacagcaacaaacgtgaaataccccgtaatcg  
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gcaataaaagaacctcatccatccactgcattgcagtgccaccgaataacgtatcatgatgattgtgtctctggaataaccgctttaga  
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ataataaatagttaacagtatattgaactgagggtctgaagaactctaatacctctgaagaactttgaggccgctagagagaaaagacca  
gtgataatatttcatcttgccatgagagcttatcatgaaagcctgtgcttaaaatcaatcattatatttattcatctttaattgaataataccaat  
atatctcatatataatttcacactacccttatctcactagacttcccgcgcataggcgcaacaatcaacgcaagttcacataaagcgggtc  
gctgcaacacatgccctagcgtctaaagtagcacgcacaacactggccagtcgtactagcccctttgcgattcgtgcagacgagcaac  
aagcgctattaaacttacctaaatttctaaccaccaccattgggtcttttccacaaactcaaaaaactcgtcaaatccgcttgcaattaaacg  
cgatgacatagatctaatcgattatcaaacccgattcaagcgtcattaaaaacgcaccactggcaagaagtctacctgcactgacca  
atatgcaagcggcggggaagagctgcctttgatcgatcaagaagaaggagcagcaagaggaaaacaatcaaaaagaggaga  
gcaatcaataaaaaacgagttattgaggattttaattttaaacaggtatattaataccctctctcgtagtaacaatgactgtatttacaa  
aaataaatagaggatatacatgtcaaacatctgggttgaaagtaccaaagattgaagtattaaaccgtcaaatggaaaactgcctgcagc  
aacttaggcattcaattacagaaattggcgaatgattatcactggcacaatgccagcagatgcacgtaccttcagccaatgggactg  
attcatggcggctcaaatgtattgctggcagaaacactgggcagcatggcagctaactgctgtatttaattgtctcaagaatattgtgttg  
ccaagaaattaacgccaaccacatacgcggtgttcgttccggcatagtgactggcacagcaacgctagtacacaaaggaagaacctc  
ccagatttgggaaattcgcatcgtaacgatccaaagaattcaaaaagcttctcgagagtacttctagagcggccgcgggcccatcgatt  
ttccacccgggtgggggtaccaggtaagtgtaccaattcgcctatagttagtcgtattacaattcactggccgtcgtttac

**Figure 5:**

Amino acid sequences expressed from vector pBK1CpnEst: - the co-expression of fragments encoding native chaperonins with the esterase gene (EstRB8), all from *Oleispira antarctica*

SEQ ID No 6: cpn10 (nucleotides 113 to 403: Frame 2 of Figure 6) 97 aa:

MKIRPLHDRVVRKEETATAGGILPGAAAEKPNQGVVISVGTGRILDNGSVQALA  
VNEGDVVVFVKYSGQNTIDIDGEELLILNESDIYGVLEA

SEQ ID No 7: cpn60 (nucleotides 455 to 2098: Frame 2 of Figure 6) 548 aa:

MAAKDVLFGDSARAKMLVGVNILADAVRVTLGPKGRNVVIEKSFGAPIITKDGVSV  
AREIELKDKFENMGAQMVKVASQANDQAGDGTTTATVLAQAIISEGLKSVAAGMN  
PMDLKRGRIDKATAAVVAAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV  
GKEGVITVEEGKGLELDVVEGMQFDRGYLSPYFINNQEKMVTVMENPLILLVDKK  
IDNLQELLPILENAVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVAAVKAPGFGD  
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS  
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVAVIKVGAGSEMEMKEKKDRVD  
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI  
AGNAGAEGSVVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPKAVTRSSLQAAASI  
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMGMPGMM

SEQ ID No 8: estRB8 (nucleotides 2579 to 3577: Frame 2 of Figure 6) 333 aa:

MKNTLKSSSRFSLKQLGTGALISSLFFGGCTTTQQDNLYTGVM SLARDSAGLEVKTA  
SAGDVNLTYMERQGSDDNAESVILLHGFSADKDNWILFTKEFDEKYHVIAVDLAG  
HGDSEQLLTTDYGLIKQAERLDIFLSGLGVNSFHLAGNSMGGAI SAIYSLSHPEKVKSL  
TLIDAAAGVDGDTSEYYKVLAEKGNPLIATDEASFEYRMGFTMTQPPFLPWPLRPSLL  
RKTLARAEINN KIFSDMLKTKERLGMTNFQQKIEVKMAQHPLPTLIMWGKEDRVLD  
VSAAAFAFKKIIPQATVHIFPEVGHLP MVEIPSESAKVYEEFLSSIK

**Figure 6:**

SEQ ID No 9: pBK1CpnEst: - the fusion of native chaperonine-coding fragments with esterase of *Oleispira antarctica* (EstRB8)

The DNA fragment coding for Cpn10 and Cpn60 is flanked by *SacI* site (pos. 69-75) and *SalI* site (encoded by pos. 2138-2143 of Figure 7):

Nucleotide positions 1-75 correspond to reverse complement of positions 1196-1121 and positions 5233-5273 correspond to reverse complement of 1043-952 of pBK-CMV vector (Stratagene)

Small letters – the Cpn10-Cpn60 encoding fragment,

Capital italics – fragments of vector pBK-CMV

Capital letters – fragment coding for EstRB8 from plasmid pBK1Est

*ACAGGAAACAGCTATGACCTTGATTACGCCAAGCTCGAAATTAACCCTCACTAAAGGGA*  
*ACAAAAGCTGGAGCTC*cctaacttgggatccaacagttggagagtctagcaaatgaaatccgtccattacatgatcgtatt  
gttgttcgccgtaaagaagaagagaccgcaactgcgggtggtattttaccgggcgctgcggcagaaaaaccaaataaggtgtgtg  
tatctctgtgggtactggccgtattcttgataatggtcagtgcaagcgctggcggttaacgaaggcgatgtgtcgttttgtaaatactc  
aggtcaaaatactatcgatatcgatggtgaagaattattgatttgaatgaaagtatactacggcggtttagaagcttaattattactca  
ctttttttaaactacaaaatttaaggaaagatcatggctgctaaagacgtattatttggtgatagcgcacgcgcaaaatgttgtaggt  
gtaaacattttagccgacgcagtaagagttaccttaggacctaaagtcgtaacggtgttatagaaaaatcatttggtgcaccgatcatcac  
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agccaacgaccaagccggtgacggcacaacgacagcgactgtactagcacaggcgattatcagcgaaggcttgaatctgttgcgg  
ctggcatgaatccaatggatcttaacgtgttattgataaagctacggctgctgttggccgcatgaaagaacaagctcagccttgcttg  
gatacaaaagcaatcgctcaggtagggaatctctgccaatgccgatgaaacgggtggtcgtttaattgctgaagcgatggaaaaagt  
cggtaaagaagggtgtgattaccgttgaagaaggcaaaggccttgaagacgagcttgatgtttagaaggcatgcagttcgatcgcggtt  
acttgtctccgtacttcatcaacaaccaagaaaaaatgaccgtagaatggaaaatccattaattctattggttgataagaaaattgataac  
cttcaagagctgttgccaattcttgaaaacgtcgttaaatcaggtcgtccattattgatcgttgctgaagatgttgaaggccaagcactagc  
aacattggtagtaacaacttgcgcggcacattcaaggttgacgcggttaaagcccctggttttggcgatcgtcgtaaagcgatgttgca  
agatcttgccatcttgacgggtggtcaggttattctgaagagctagggatgtcttagaaactgcggatccttcttcttggttacggcaa  
gcaagggtgttatcgataagaaaacaccgtgattgttgatggcgacgtactgaagcaagcgtaatactcgtgttgaccagatccgtg  
ctgaaatcgaaagctcgacttctgattacgacatcgaaaagtacaagaacgcgttgctaagcttgcggcgccggttgccgtgattaag



gttggtgcgggttctgaaatggaaatgaaagagaagaaagaccgtgttgacgatgcacttcatgcaactcgcgcagcgggtgaagaag  
gtgttgttcggggtggtggtgttccttgattcgcgcactctcttcagtaaccgttgttggtgataacgaagatcaaacgtcgggtattgcat  
tggcacttcgtgcgatggaagctcctatccgtcaaatcgcgggtaacgcaggtgctgaagggtcagtggtgttgataaagtgaatctg  
gcacaggtagctttggtttaacgccagcacaggtgagtatggcgatatgattgcgatgggtatttagaccctgcaaaagtcacgcgttc  
atctctacaagccgcggcgctctatcgcaggttgatgatcacaaccgaagccatgggtgcggatgcgcctgtgaagaaggcgctggtg  
gtatgcctgatatggcgggcatgggtggaatggcggtatgcctggcatgatgtaatcactttgtgattcattgtctgatctgctaccgt  
GTCGACATATTCAAGATAAAGATGCCTTCACTGACATCAGTCACCAACAATCAAT  
CAAACACCAATACCAATCGCAAAAACCTCATAAACTAGCCGATCACCAAAATCCC  
AAAAGCGTTCAAAAATGAAACGAGCACGTCACACAAAATCAATTTATACGCTAA  
CGAACCAGGTCAAACCTTATCGTTTTTTTGTAGCACGTTTGTTCCTACTAATGAAAGA  
GAAAAGTCGTTAATTCAGTGGCTTTTGGCGTATCCGCACCTTCACATAGAAATTA  
GTAATGGCATGCTACTGGCCTTTAAAAAGAATCAGTTAATTGAAGAAACCTCGCT  
TATCTCAGCCATTACCGCTGTAGCCGAATTTGCGCTTATCCTCAGCCATGATTAAA  
CTGACGCCAATTAATATAAGACATACTAATTAATAACTCCCTTAATTGAGAAGAA  
TAATGAAAAACACACTCAAATCCTCATCACGTTTTAGTCTGAAACAACCTCGGCAC  
CGGCGCTCTGATTATCTCCAGTTTGTCTTTCGGTGGTTGCACCACAACACAACAAG  
ATAATTTATACACAGGGGTTATGTCTCTTGCGAGAGACAGCGCTGGCCTAGAAGT  
TAAAACAGCCTCTGCCGGTGACGTCAATCTTACTTATATGGAACGCCAAGGCAGT  
GACAAAGATAATGCCGAAAGCGTTATTTTATTACACGGTTTCTCTGCTGATAAAG  
ATAACTGGATTCTTTTTACCAAAGAATTCGATGAAAAATATCATGTTATCGCTGTC  
GATTTAGCGGGACATGGCGATTGAGAACAAATTATTAACGACTGATTACGGTCTCA  
TAAAACAAGCCGAGCGTTTAGATATCTTCTTATCTGGCTTAGGGGTTAACTCATT  
CACATCGCCGGTAATTCAATGGGGGGGGCTATCAGCGCAATCTACAGTTTGAGTC  
ACCCAGAGAAAGTTAAAAGTCTTACATTGATCGATGCAGCAGGTGTCGATGGCG  
ATACTGAAAGCGAATACTACAAAGTTTTGGCAGAAGGTAAGAATCCTTTAATTGC  
AACTGATGAAGCAAGTTTTGAATACCGCATGGGTTTCACCATGACTCAGCCTCCT  
TTCCTACCTTGGCCACTAAGACCTTCTTTATTACGTAAAACGCTAGCCCGTGCCGA  
GATCAATAACAAAATTTTTCCGATATGCTGAAAACCAAAGAACGTTTAGGAATG  
ACTAACTTTCAACAGAAAATTGAAGTGAAAATGGCTCAACATCCATTGCCAACAC  
TGATTATGTGGGGCAAAGAAGATCGCGTTCTTGACGTATCCGCAGCAGCGGCCTT  
CAAAAAAATAATTCCACAAGCAACTGTTTCATATTTTTCTGAAGTAGGCCACCTA  
CCTATGGTAGAAATTCCTAGTGAAAGCGCTAAAGTTTATGAAGAGTTTTGTCTCT  
CTATTAAATAAGAGCACATAATCATGACTGACTTATAAACAGCCAAGCATTTAAA  
ATGCTTGGCTGTTTATTTTAATGGCCAAATTATTCAACGACCAAGCTCTGCGGTAA

AATCGCAGTGGGTTTCTTGTTTTTCATCAACAGCAACAAACGTGAAATACCCCGTA  
ATCGCATTTTTCTGATTATCAAAATACATACTTTCCACCAGCATATTAAC TTCAAC  
TTTTAAACTCGTCCGCCCTACCTCTATAACACTGGCAGTCAATTCGACAATGGTAC  
CTGCGGGAACAGGATGCTTAAAATCGATTGATCACTGCTGACGGTTACGATGCT  
TTGTGAGAAAAACGAGTCGCTGCAATAAAAGAAACCTCATCCATCCACTGCATT  
GCAGTGCCACCGAATAACGTATCATGATGATTTGTTGTCTCTGGAAATACCGCTTT  
AGAAATAGTGGTTTTTGATACGCGCTTTGCTGCGCAATAATATCTTCTCTGCTAA  
GAGTTGCGGATGGCATACTAACTCGCTTGATTAAGATTAATAATAATAGTTA  
ACAGTATATTGAACTGAGGGTCTGAAGAACTCTAATACCTCTGAAGAACTTTGAG  
GCCGCTAGAGAGAAAAGACCAGTGATAATATTTTCATCTTGCCATGAGAGCTTATC  
ATGAAAGCCTGTGCTTAAAATCAATCATTATATTTATTTCATCTTTAATTGAAATAA  
TACCAATATATTTTCATATATAATTTTCACTACCCTTATCTCACTAGACTTCCCGC  
GCATAGGCGCAAACAATCAACGCAAGTTCACAATAAAGCGGTTGCTGCAACAC  
ATGCCCTAGCGTCTAAAGTAGCACGCACAACACTGGCCAGTCGTACTAGCCCCTT  
TGCGATTGCTGCAGACGAGCAACAAGCGCTATTAAACTTACCTAAATTTCTAACC  
ACCACCATTGGTTCTTTTCCACAACTCAAAAACTCGTCAAATCCGCTTGCAATT  
TAAACGCGATGACATAGATCTAATCGATTATCAAACCCGCATTCAAGCGCTCATT  
AAAAACGCACCACTGGCAAGAAGTTCTACCTGCACTGACCAATATGCAAGCGGC  
GGCGGAAGAGCTGCCTTTGATCGATCAAGAAGAAGGGAGCAGCAAAGAGGAAA  
ACAATCAAAAAGAGGAGAGCAATCAAATAAAAACGAGTTATTGAGGATTTTAAT  
TTTAAACAGGTATATTAATACCCTCTCTCGTAGTAAACAATGACTGTATTTACAC  
AAAAATAAATAGAGGTATACCATGTCAAACATCTGGTTTGAAGTACCAAAGATTG  
AAGTATTAAACCGTCAAATGGAAAATACTGCCTGCAGCAACTTAGGCATTCAAAT  
TACAGAAATTGGCGATGATTATATCACTGGCACAATGCCAGCAGATGCACGTACC  
TTCCAGCCAATGGGACTGATTCATGGCGGCTCAAATGTATTGCTGGCAGAAACAC  
TGGGCAGCATGGCAGCTAACTGCTGTATTAATTTGTCTCAAGAATATTGTGTTGG  
CCAAGAAATTAACGCCAACACATACGCGGTGTTTCGTTCCGGCATAGTGACTGGC  
ACAGCAACGCTAGTACACAAAGGAAGAACCTCCCAGATTTGGGAAATTGCGATC  
GTTAACGATCCAAAGAATTCAAAAAGCTTCTCGAGAGTACTTCTAGAGCGGCCGCGGG  
CCCATCGATTTTCCACCCGGGTGGGGTACCAGGTAAAGTGATCCCAATTCGCCCTATAGT  
GAGTCGTATTACAATTCCTGACCGGTCGTTTTAC

**Figure 7:**

Amino acid sequences expressed from vector pBK1CpnSREst: - the co-expression of the stabilized single ring mutant chaperonin with the esterase gene (EstRB8) from *Oleispira antarctica* (cpn10::stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala::est)

SEQ ID No 10: cpn10 (nucleotides 113 to 403: Frame 2 of Figure 8) 97 aa:

MKIRPLHDRVVRRKEEETATAGGILPGAAAEKPNQGVVISVGTGRILDNGSVQALA  
VNEGDVVVF GKYSQNTIDIDGEELLILNESDIYGVLEA

Below – **Capital bold letters** are the mutations introduced

SEQ ID No 11: stabilized single ring mutant of cpn60 (nucleotides 455 to 2098: Frame 2 of Figure 8) 548 aa:

MAAKDVLFGDSARAKMLVGVN~~L~~ADAVR~~V~~TLGPKGRNVVIEKSFGAPIITKDGVSV  
AREIELKDKFENMGAQMVKEVASQANDQAGDGT~~T~~TTATVLAQAIISEGLKSVAAGMN  
PMDLKRGRIDKATAAVVAAI**K**EQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV  
GKEGVITVEEGKGLEDEL~~D~~VVEGMQFDRGYLSPYFINNQEKM~~T~~VE~~M~~ENPLILLVDKK  
IDNLQELLPILE~~N~~VAKSGRPLLVAEDVEGQALATLVVNNLRGTFKVA~~A~~VKAPGFGD  
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS  
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVAVIKVGAGSEMEMKEKKDRVD  
DALHATRAAVEEGVVAGGGVALIRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI  
AGNAGA4G4A1VVDKVKSGTGSFGFNASTGEYGDMIAMGILDPKAVTRSSLQAAASI  
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMGMPGMM

SEQ ID No 12: EstRB8 (nucleotides 2579 to 3577: Frame 2 of Figure 8) 333 aa:

MKNTLKSSSRFSLKQLGTGALISSLFFGGCTTTQQDNLYTGVM~~S~~LARDSAGLEVKTA  
SAGDVNLTYMERQGS~~D~~KDNAESVILLHGFSADKDNWILFTKEFDEKYHVIAVDLAG  
HGDSEQLLTTDYGLIKQAERLDIFLSGLGVNSFH~~I~~AGNSMGGAI~~S~~AIYSLSHPEKVKSL  
TLIDAAGVDGDTESEYYKVLAE~~G~~KNPLIATDEASFEYRMGFTMTQPPFLPWPLRPSLL

RKTLARAEINNKFSDMLKTKERLGMTNFQQKIEVKMAQHPLPTLIMWGKEDRVLD  
 VSAAAAFKKIIPQATVHIFPEVGHLPMEIPSESAKVYEEFLSSIK

**Figure 8:**

SEQ ID No 13: DNA sequence of vector pBK1CpnSREst: the expression cassette for the co-expression of the stabilized single ring mutant chaperonin with the esterase gene (EstRB8) from *Oleispira antarctica* (cpn10::stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala::est)

Nucleotide positions 1-75 correspond to reverse complement of positions 1196-1121 and positions 5233-5273 correspond to reverse complement of 1043-952 of pBK-CMV vector (Stratagene)

DNA fragment coding for Cpn10 and Cpn60 is flanked by *SacI* site (pos. 69-75) and *SalI* site (pos. 2138-2143).

In the DNA sequence:

Small letters – the Cpn10-Cpn60 coding fragment,

Capital italics – fragments of vector

Capital letters – fragment coding for EstRB8 from plasmid pBK1Est

Capital bold letters = introduced mutations

*ACAGGAAACAGCTATGACCTTGATTACGCCAAGCTCGAAATTAACCCTCACTAAAGGGA*  
*ACAAAAGCTGGAGCTC*cctaacttgggatccaacagttggagagtctagcaaatgaaatccgtccattacatgatcgtatt  
 gttgttcgccgtaaagaagaagagaccgcaactgcgggtggtattttaccggcgctgcggcagaaaaacaaatcaaggtgtgt  
 tatctctgtgggtactggccgtattcttgataatggttcagtgcaagcgctggcgggtaacgaaggcgtgtgtcgttttgtaaatactc  
 aggtcaaaatactatcgatatcgatggtgaagaattattgatttgaatgaaagtatatctacggcggtttagaagcttaattattactca  
 cttttttttaacctacaaaatttaaggaaagatcatggctgctaaagacgtattatttggtgatagcgacgcgcaaaaatgttgtaggt  
 gtaaacatttttagccgacgcagtaagagttaccttaggacctaaaggtcgtaacgttggttatagaaaaatcatttggtgcaccgatcatcac  
 caaagatggtgtttctgttcgcgtgaaatcgaattgaaagacaaatcgaaaacatggcgacagatggttaaggaagtgcttctca  
 agccaacgaccaagccggtgacggcacaacgacagcgactgtactagcacaggcgattatcagcgaaggctgaaatctgttcggg  
 ctggcatgaatccaatggatcttaaacgtggtattgataaagctacggctgctgtgttgccgccattaaagaacaagctcagccttgcttg

gatacaaaagcaatcgctcaggtagggacaatctctgccaatgccgatgaaacggttggtcgttaattgctgaagcgatggaaaaagt  
cggtaaagaaggtgtgattaccgttgaagaaggcaaaaggccttgaagacgagcttgatgtttagaaggcatgcagttcgatcgcggtt  
acttgtctccgtacttcatcaacaaccaagaaaaatgaccgtagaaatggaaaaatccattaattctatttggtgataagaaaattgataac  
cttcaagagctgttgccaattcttgaaacgtcgctaaatcaggtcgctcattattgatcgttgctgaagatgttgaaggccaagcactagc  
aacattggtagtaacaacttgcgcggcacattcaaggttgcagcgggttaaagcccctggttttggcgatcgtcgtaagcgatgttgca  
agatcttgccatcttgacgggtggtcaggttatttctgaagagctagggtatgtcttagaaactcgggatccttcttcttggttacggcaa  
gcaaggttggtatcgataaagaaaacaccgtgattgttgatggcgaggtactgaagcaagcgtaatactcgtgttgaccagatccgtg  
ctgaaatcgaaagctcgacttctgattacgacatcgaaaagttacaagaacgcgttgctaagcttgcggggcggttgccgtgattaag  
gttggtgcgggttctgaaatggaaatgaaagagaagaagaccgtgttgacgatgcacttcatgcaactcgcgcagcgggtgaaagaag  
gtgtgttgcggttggtgtgtgttgattcgcgcactctcttcagtaaccgttggttggtgataacgaagatcaaacgcgtgattgcat  
tggcacttctgcatggaagctctatccgtcaaatcgcggttaacgcaggtgctgCagggGcagCggtgttgataaagtgaat  
ctggcacaggtagcttttggtttaacgccagcacaggtgagtatggcgatatgattgcgatgggtatttttagaccctgcaaaagtcacgc  
gttcatctctacaagccgcggcgtctatcgaggttgatgatcacaaccgaagccatggttgcgatgcgcctgttgaagaaggcgct  
ggtggtatgcctgatatggcgggcatgggtggaatggcggtatgcctggcatgatgaatcactttgtgattcattgtcctgatctgctta  
ccgtGTCGACATATTCAAGATAAAGATGCCTTCACTGACATCAGTCACCAACAATC  
AATCAAACACCAATACCAATCGCAAAAACCTCATAAACTAGCCGATCACCAAAAT  
CCCAAAAGCGTTCAAAAATGAAACGAGCACGTCACACAAAATCAATTTATACGC  
TAACGAACCAGGTCAAACCTTATCGTTTTTTTGAGCACGTTTGTTCCTAATGAAA  
GAGAAAAGTCGTTAATTCCTGGCTTTTGGCGTATCCGCACCTTCACATAGAAAT  
TAGTAATGGCATGCTACTGGCCTTTAAAAAGAATCAGTTAATTGAAGAAACCTCG  
CTTATCTCAGCCATTACCGCTGTAGCCGAATTTGCGCTTATCCTCAGCCATGATTA  
AACTGACGCCAATTAATATAAGACATACTAATTAATAACTCCCTTAATTGAGAAG  
AATAATGAAAAACACACTCAAATCCTCATCACGTTTTAGTCTGAAACAACCTCGGC  
ACCGGCGCTCTGATTATCTCCAGTTTGTCTTTCGGTGGTTGCACCACAACACAACA  
AGATAATTTATACACAGGGGTATGTCTCTTGCGAGAGACAGCGCTGGCCTAGAA  
GTTAAACAGCCTCTGCCGGTGACGTCAATCTTACTTATATGGAACGCCAAGGCA  
GTGACAAAGATAATGCCGAAAGCGTTATTTTATTACACGGTTTCTCTGCTGATAA  
AGATAACTGGATTCTTTTACCAAAGAATTCGATGAAAAATATCATGTTATCGCT  
GTCGATTTAGCGGGACATGGCGATTCAGAACAATTATTAACGACTGATTACGGTC  
TCATAAAACAAGCCGAGCGTTTAGATATCTTCTTATCTGGCTTAGGGGTAACTC  
ATTTACATCGCCGGTAATTCAATGGGGGGGGCTATCAGCGCAATCTACAGTTTG  
AGTCACCCAGAGAAAGTTAAAAGTCTTACATTGATCGATGCAGCAGGTGTCGATG  
GCGATACTGAAAGCGAATACTACAAAGTTTTGGCAGAAGGTAAGAATCCTTTAAT  
TGCAACTGATGAAGCAAGTTTTGAATACCGCATGGGTTTCACCATGACTCAGCCT

CCTTTCCTACCTTGGCCACTAAGACCTTCTTTATTACGTAAAACGCTAGCCCGTGC  
CGAGATCAATAACAAAATTTTTTCCGATATGCTGAAAACCAAAGAACGTTTAGGA  
ATGACTAACTTTCAACAGAAAATTGAAGTGAAAATGGCTCAACATCCATTGCCAA  
CACTGATTATGTGGGGCAAAGAAGATCGCGTTCTTGACGTATCCGCAGCAGCGGC  
CTTCAAAAAAATAATTCCACAAGCAACTGTTTCATATTTTTCTGAAGTAGGCCAC  
CTACCTATGGTAGAAATTCCTAGTGAAAGCGCTAAAGTTTATGAAGAGTTTTTGT  
CCTCTATTAAATAAGAGCACATAATCATGACTGACTTATAAACAGCCAAGCATTT  
AAAATGCTTGGCTGTTTATTTTAATGGCCAAATTATTCAACGACCAAGCTCTGCG  
GTAAAATCGCAGTGGGTTTCTTGTTTTTCATCAACAGCAACAAACGTGAAATACCC  
CGTAATCGCATTTTTCTGATTATCAAAATACATACTTTCCACCAGCATATTAATT  
CAACTTTTAAACTCGTCCGCCCTACCTCTATAACACTGGCAGTCAATTCGACAATG  
GTACCTGCGGGAACAGGATGCTTAAAATCGATTTCGATCACTGCTGACGGTTACGA  
TGCTTTGTGCGAGAAAAACGAGTCGCTGCAATAAAAGAAACCTCATCCATCCACTG  
CATTGCAGTGCCACCGAATAACGTATCATGATGATTTGTTGTCTCTGGAAATACC  
GCTTTAGAAATAGTGGTTTTTGATACGCGCTTTCGCTGCGCAATAATATCTTCTCT  
GCTAAGAGTTGCGGATGGCATACTAAACTCGCTTGATTAAGATTAATAATAAAT  
AGTTAACAGTATATTGAACTGAGGGTCTGAAGAACTCTAATACCTCTGAAGAACT  
TTGAGGCCGCTAGAGAGAAAAGACCAGTGATAATATTTTCATCTTGCCATGAGAGC  
TTATCATGAAAGCCTGTGCTTAAAATCAATCATTATATTTATTCATCTTTAATTGA  
AATAATACCAATATATTTTCATATATAATTTACACTACCCTTATCTCACTAGACTT  
CCCGCGCATAGGCGCAAACAATCAACGCAAGTTCACAATAAAGCGGTTCGCTGC  
AACACATGCCCTAGCGTCTAAAGTAGCACGCACAACACTGGCCAGTCGTACTAGC  
CCCTTTGCGATTTCGTGCAGACGAGCAACAAGCGCTATTAAACTTACCTAAATTTT  
TAACCACCACCATTTGGTTCTTTTCCACAACTCAAAAAACTCGTCAAATCCGCTTG  
CAATTTAAACGCGATGACATAGATCTAATCGATTATCAAACCCGCATTCAAGCGC  
TCATTAAAAACGCACCACTGGCAAGAAGTTCTACCTGCACTGACCAATATGCAAG  
CGGCGGCGGAAGAGCTGCCTTTGATCGATCAAGAAGAAGGGAGCAGCAAAGAGG  
AAAACAATCAAAAAGAGGAGAGCAATCAAATAAAAACGAGTTATTGAGGATTTT  
AATTTTAAACAGGTATATTAATACCCTCTCTCGTAGTAAACAATGACTGTATTTA  
CACAAAAATAAATAGAGGTATACCATGTCAAACATCTGGTTTGAAGTACCAAAG  
ATTGAAGTATTAAACCGTCAAATGGAAAATACTGCCTGCAGCAACTTAGGCATTC  
AAATTACAGAAATTGGCGATGATTATATCACTGGCACAATGCCAGCAGATGCACG  
TACCTTCCAGCCAATGGGACTGATTCATGGCGGCTCAAATGTATTGCTGGCAGAA  
ACACTGGGCAGCATGGCAGCTAACTGCTGTATTAATTTGTCTCAAGAATATTGTG

TTGGCCAAGAAATTAACGCCAACCACATACGCGGTGTTTCGTTCCGGCATAAGTGAC  
TGGCACAGCAACGCTAGTACACAAAGGAAGAACCTCCCAGATTTGGGAAATTTCG  
CATCGTTAACGATCCAAAGAATTCAAAAAGCTTCTCGAGAGTACTTCTAGAGCGGCCG  
CGGGCCCATCGATTTTCCACCCGGGTGGGGTACCAGGTAAGTGTACCCAATTCGCCCT  
ATAGTGAGTCGTATTACAATTCACTGGCCGTCGTTTTAC

**Figure 9:**

Amino acid sequence of the stabilized single ring mutant Glu461Ala/Ser463Ala/Val464Ala of Cpn60:

SEQ ID No 14: Cpn10 (nucleotides 458-751 of Figure 10):

MKIRPLHDRVVRRKEEETATAGGILPGAAAEKPNQGVVISVGTGRILDNGSVQALA  
VNEGDVVVFGKYSGQNTIDIDGEELLILNESDIYGVLEA

SEQ ID No 15: Cpn60 (nucleotides 458-751 of Figure 10):

MAAKDVLFGDSARAKMLVGVNLADEVRTLGPKGRNVVIEKSFGAPIITKDGVSV  
AREIELKDKFENMGAQMVKEVASQANDQAGDGTTTATVLAQAISEGLKSVAAGMN  
PMDLKRGIDKATAAVVAAIKEQAQPCLDTKAIAQVGTISANADETVGRLIAEAMEKV  
GKEGVITVEEGKGLEDEL DVVEGMQFDRGYLSPYFINNQEKM TVEMENPLILLVDKK  
IDNLQELLPILENVAKSGRPLLIVAEDVEGQALATLVVNNLRGTFKVA AVKAPGFGD  
RRKAMLQDLAILTGGQVISEELGMSLETADPSSLGTASKVVIDKENTVIVDGAGTEAS  
VNTRVDQIRAEIESSTSDYDIEKLQERVAKLAGGVA VIKVGAGSEMMEK KDRVD  
DALHATRAAVEEGVVAGGGVALRALSSVTVVGDNEDQNVGIALALRAMEAPIRQI  
AGNAGAAGAAVVDKVKSGTGSFGFNASTGEYGDMIAMGILDPK VTRSSLQAAASI  
AGLMITTEAMVADAPVEEGAGGMPDMGGMGGMGGMGMPGMM

**Figure 10:**SEQ ID No 16: DNA sequence of the stabilized single ring mutantGlu461Ala/Ser463Ala/Val464Ala:

In the DNA sequence:

Small letters – the Cpn10-Cpn60 coding fragment,

Big bold letters = introduced mutations

atcaaaaaatgcagcaaggacagattcctgcccgaagaattagcagaagggttcttggtagcactggccggcgctttattattaacgcccgg  
 gttttgctactgatgcgctgggttttactactcgtccccgcgacgcgtaaaagcggtggtccataagggtgattgcatttattaccctc  
 .gcatgatgactgcaagcagctttcaagcgacgggtagttttcaggaaggctcgttaaagatgtacattcgcacactgactcgcaaaagca  
 gtcataaaaaatcacaattgaaggcgaatatacaaagacgataagtaggtatttttcggctagccgttgaaatcctagtaaaagccc  
 cgataaattaaccatctatttttcacagaggcaatttagccttggttacctattgatcctaatactgggatccaacagttggagagtctagc  
 aaatgaaaatccgtccattacatgatcgtattgtgttcgccgtaaaagaagaagagaccgcaactgcgggtggtatttttacc  
 gggcgctgcggcagaaaaacaaatcaagggtgtgttatctgtgggtactggccgtattcttgataatggttcagtgaagcgctggc  
 ggtaacgaaggcgatgtgtcgttttggtaaatactcagggtcaaaatactatcgataatgatgtgaagaattattgattttgaatga  
 aagtatactacggcggtttagaagcttaattattacactcactttttttaaactacaaaatttaaggaaagatcatggctgctaaagacg  
 tattatttggtgatagcgacgcgcaaaaatgttggtagggtgaacatttttagccgacgcagtaagagttaccttaggacctaa  
 aggtcgtaacgtgttatagaaaaatcatttggtgcaccgatcatcacaaagatggtgttctgttgcgctgaaatcgaattgaaagaca  
 aattcgaaaacatgggcgcacagatggttaagggaagtgcttctcaagccaacgaccaagccgggtgacggcacaacgacagcgact  
 gtactagcacaggcgattatcagcgaaggcttgaatctgttgcggctggcatgaatccaatggatcttaaacgtggtattgataaagcta  
 cggctgctgtgttgcgccattaaagaacaagctcagccttgggtgatacaaaagcaatcgctcaggtagggacaatctctgccaatg  
 ccgatgaaacggttggtcgttaattgctgaagcgatggaaaaagtcggtaaaagaggtgtgattaccgttgaagaaggcaaaagcctt  
 gaagacgagcttgatgtttagaaggcatgcagttcgatcgcggttactgtctccgtacttcatcaacaaccaagaaaaatgaccgta  
 gaaatggaaaatccatttaattctattggttgataagaaaattgataacctcaagagctgttgccaattctgaaaacgtcgtaaatcaggt  
 cgtccattattgatcgtgtgtaagatgttgaaaggccaagcactagcaacattggtagtaaaacaacttgcgcggcacattcaagggtgc  
 agcgggttaaagcccctggtttggcgatcgtcgttaaagcgatgttgcaagatcttgccatcttgacgggtggtcaggtatttctgaagag  
 ctagggatgtctttagaaactcggtatccttcttgggtacggcaagcaagggtgttatcgataaagaaaacaccgtgattgttga  
 tggcgaggtactgaagcaagcgttaatactcgtgtgaccagatccgtgctgaaatcgaagctcgacttctgattacgacatcgaaaa  
 gttacaagaacgcgttgctaagcttgcggggcggttccgtgattaagggttggtgcgggttctgaaatggaaatgaagagaagaaa  
 gaccgtgttgacgatgcacttcatgcaactcgcgcagcggtgaagaaggtgtgttcgggtggtggtgtgttcttattcgcgcaactct  
 cttcagtaaccgtgtgttggtgataacgaagatcaaaacgtcggtattgcattggcacttcgtcgatggaagctcctatccgtcaaatcgc



gggtaacgcaggtgctgCagggGcagCggttgatgataaagtgaaatctggcacaggtagcttgggtttaacgccagcacaggtg  
agtatggcgatagattgcgatgggtatttagaccctgcaaaagtcacgcgttcattctctacaagccgcggcgctctatcgcaggttgat  
gatcacaaccgaagccatggttcgggatgcgcctgttgaagaaggcgcgtggtggtatgcctgatatgggcggcatgggtggaatggg  
cggtatgcctggcatgatgtaatactttgtgattcattgtcctgatctgctaccgtgtaaaaagatcaggctcaaggctgtctctataaaa  
agccgtatctttgatgagtgttctttctgctgaaaacgacattcttgagtgccgcttttttgattttggtcataaaattcagaatattgtgta  
attttatgtaactagctggcctataatgttgagttcctctgggtggcatgatctcatggtacttcacttaagcctgattcactgcg  
gctttaacagtaaaataataacgcaacgtagaaacataataagcgtatggcattaatgaagacggctgcatttaattcagatc

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